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A MANUAL FOR THE EVALUATION OF A STATE DRINKING WATER SUPPLY PROGRAM

U.S. ENVIRONMENTAL PROTECTION AGENCY

WATER SUPPLY DIVISION

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This manual is designed to provide guidance for persons conducting evaluations of state drinking water supply programs and to serve as a model which can be used by state regulatory agencies to develop an effective drinking water supply program. Simply stated, a state water supply program evaluation should be undertaken to determine the nature of the program; its effectiveness in providing public health control of public water supplies and to recommend measures that will result in an improvement in program capability. One of the initial decisions that had to be made in the development of the manual was whether or not to include the area of individual water supply systems.

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A MANUAL FOR THE EVALUATION OF A STATE DRINKING WATER SUPPLY PROGRAM

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Water Supply Division

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To all members of the CSSE Water Supply Committee, the Water Supply Division expresses its sincere gratitude.

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PREFACE

This manual is designed to provide guidance for persons conducting evaluations of State drinking water supply programs and to serve as a model which can be used by State regulatory agencies to develop an effective drinking water supply program. Simply stated, a State water supply program evaluation should be undertaken to determine the nature of the program; its effectiveness in providing public health control of public water supplies and to recommend measures that will result in an improvement in program capability.

One of the initial decisions that had to be made in the development of the manual was whether or not to include the area of individual water supply systems (systems serving a single dwelling unit occupied by one household). There is generally agreement that States should, and do, provide assistance to improve individual water supply systems. There is a fundamental difference, however, between an individual system and one serving the public. These latter systems constitute a significant potential public health threat, if not properly regulated. Just as in any other area of consumer protection, the public has a right to expect that the government will provide, and enforce, certain safeguards. On the other hand, regulation of an individual's water supply system is not a proper role for the State government. State involvement should generally be limited to providing technical assistance to improve these supplies through county and local health or environmental agencies. It was therefore concluded that individual water supply systems would not be treated throughout the main body of the manual, but be consolidated in Appendix A.

Specifically, this manual was conceived for three purposes:

- To serve as a guide for EPA regional personnel to use in conducting evaluations of State water supply programs.
- To provide a guide that the States can use in evaluating their own programs.
- To provide sufficient criteria, standards, and guidelines for the development of a model State water supply program that will effectively regulate and insure a healthful and safe supply of drinking water to the public.

The manual was written to provide a method to identify program deficiencies and to propose criteria by which corrective measures can be developed. In conducting an evaluation, it is important to identify strengths as well as weaknesses. It is equally important to recognize that there is more than one approach to the development and operation

of a sound State water supply program. The current program must be viewed with respect to the end results being achieved.

Abstract

The manual contains three principal sections:

Section 1 — *State Water Supply Program Authority*
This section of the manual discusses the three major spheres or divisions of authority under which a State water supply program normally operates: (a) legal statutes; (b) administrative rules and regulations; and (c) water supply program policy. The section further details those areas of drinking water activity for which legal authority should be provided.

Section 2 — *State Water Supply Program Activities and Resources*
This section of the manual lists the principal drinking water activities that should be established in the water supply program office to enable the program to conduct an effective regulatory and surveillance program and provides guidelines for competent and efficient performance of these activities. The section also provides criteria for monetary and manpower resources needed for operation of program activities and accomplishment of program objectives.

Section 3 — *Current Status of State Water Supply Systems*
The effectiveness of a State water supply program cannot be fully determined without an evaluation of the current conditions of water supply systems in the State. This section of the manual provides guidelines for the evaluation of a State's drinking water supplies. Subjects discussed include: (a) criteria for selecting a representative number of public water supplies for study; (b) current assessment of water supply systems based on a field survey of existing conditions and/or examination of pertinent data recorded in State, county, or water utility files; and (c) important sanitary features of a water supply system and their health significance.

Appendix A through Appendix C and References — *The appendices and references* supply some of the background information and rationale on which the elements of this manual were based.

Definitions

For the purposes of this manual, drinking water systems are defined as follows:

- *public water supply system*—any system which provides water to the public for consumption, excluding water sold in bottles or other closed containers.
  - — community water supply systems—a public system that provides water to ten or more premises not owned or controlled by the supplier of water or to forty or more resident individuals.
  - — *other public water supply systems*—all other systems which provide water for public consumption, exclusive of individual water supply systems.
- *individual water supply system*—a water supply system that serves a single dwelling unit occupied by one household.

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INTRODUCTION

The classical communicable waterborne diseases of years past—typhoid fever, amoebic dysentery, and bacillary dysentery—were brought under control by the 1930's. Today, drinking water supplies in cities and towns of the United States rank in quality, on the average, among the best in the world. This situation came about because a great deal of money and effort was expended by the State Health Departments and the U.S. Public Health Service to improve State water supply programs largely by training and staffing the State regulatory programs with highly qualified engineers and health professionals. In addition, attention focused on the health significance of drinking water during that period was instrumental in the large increase of new facilities for water supply and wastewater treatment.

The control of waterborne disease was successful and the attention and emphasis on water hygiene problems declined. The nation's primary interest shifted to other environmental problems. The Federal level of spending for these programs reached more than 470 million dollars in Fiscal Year 1973. The major portion was allocated for wastewater and air pollution control efforts.

Wastewater control efforts are sorely needed to minimize future pollution of our drinking water sources, but it is clear that water pollution control efforts alone cannot assure a safe drinking water. Wastewater treatment processes do not remove all of today's known potential toxicants or biological agents prior to discharge. In addition, there are pollutants which affect sources of drinking water which are not subject to any waste treatment. Such pollutants are found in the runoff from fields and forests, and from chemicals spilled in transportation accidents. Both adversely affect quality at the water treatment plant intake. Water pollution control efforts can assist the delivery of safe water to the consumer's tap by improving raw water quality, but the drinking water supply system is the last and most vital means to protect the public's health. Both today and in the future, delivery of adequate supplies of safe water at the consumer's tap will be dependent upon properly designed, constructed and operated water treatment plants and distribution systems. Even where a water treatment plant produces high quality water, adequate safeguards are required to prevent degradation in the distribution system.

Only through the close scrutiny of competent State and local water supply agencies can the public be assured that a safe water is being produced and delivered to the consumer. These agencies must have adequate authority and resources to conduct necessary planning, training, and technical assistance activities to assure full application of

existing technology and to execute active, constructive surveillance and enforcement programs.

The water utility is responsible for the continuous quality and safety of the water it produces. However, the State agency, as the overseer of operations on behalf of the public, is ultimately responsible for insuring the adequacy and safety of all drinking water in the State. The State must provide the health evaluation and engineering services necessary to fulfill its responsibilities to protect the health of the public.

Few, if any, States currently have water supply programs that fully provide the health evaluation and engineering services necessary to fulfill these responsibilities. This is not because of a lack of will or understanding of the importance of surveillance. It is principally because of lack of personnel, and of budgetary limitations. A State water supply program may possess inadequate authority and resources to provide effective planning, training, and technical assistance, and may also lack the enforcement and monitoring programs to correct these problems.

In most instances, a substantial expansion of the State water supply program is needed to meet the needs for trained personnel, laboratory facilities and other support necessary for the conduct of an effective surveillance and regulatory program.

Section I STATE WATER SUPPLY PROGRAM AUTHORITY

Adequate statutes, regulations and policies are the basis for the development of an effective State program for the regulatory control of public water supply systems.

It is often difficult to draw well-defined lines of distinction between provisions that should be provided by statute and those that should be established by administrative authority. Both generally constitute legally enforceable authority. It is recognized that some State water supply statutes are general in nature and delegate to the administrative agency a broad latitude of authority to adopt rules and regulations for the supervision of the State's drinking water program. Other States' statutes are more specific in language, stipulating certain regulatory provisions the administrative agency is directed to adopt. The important consideration however is that the two legal means of establishing water supply authority complement and supplement each other. Together the statutes and the administrative rules and regulations should constitute a complete and effective regulatory mechanism on which a sound water supply program can be based.

The criteria for reviewing the adequacy of State water supply program authority that will be discussed in this section will be based on the following principles:

- The State statute or code should specifically stipulate key water supply regulatory provisions.
- The responsible administrative agency should establish, with the authority provided by statute, detailed rules and regulations that are necessary and essential for a comprehensive and effective water supply program.

1.1.0 *Statutory Authority*

The State drinking water statute(s) should include the following basic elements:

- Scope of State authority
- Delegation of administrative responsibility
- Specific statutory regulations
- Provisions for compliance.

Legal statutes should provide full statutory authority over all public drinking water supplies in the State. The types of water supplies regulated by the State should be specified and clearly defined.

The statute(s) should:

- Designate an administrative agency of the State to execute and administer all statutory provisions.
- Vest in the Administrator sufficient authority to establish, amend and enforce all rules and regulations necessary for the orderly development, maintenance and protection of drinking water for the general public.

The Administrator may be a department or agency of a State government, a State board or an individual (hereafter referred to as the "Administrator"). While principal drinking water authority should reside in one department or agency of the State, many other activities relating to drinking water may be located elsewhere in the State organizational structure. Where this situation exists, the respective responsibilities should be clearly identified and adequate procedures developed to assure proper coordination.

1.1.1 *Specific Statutory Provisions*

While State water supply statutes are often general in nature and delegate responsibility for establishing specific water supply regulatory provisions, the regulatory authority can be significantly reinforced if the more important water supply functions or program activities are established by statutory enactment. The statute(s) should require the adoption of the necessary detailed rules and regulations for the following specific water supply functions and program activities:

- Drinking water quality standards
- Water supply facilities criteria
- Submission, review, and approval of preliminary engineering studies and detailed plans and specifications
- Approval of a water supply source and treatment requirements
- Establishment of a well construction and pump installation code
- Operator certification
- Provision for State laboratory services
- Cross-connection and plumbing control regulations.

1.1.2 *Provisions for Compliance*

The statute(s) should provide for compliance with all laws, rules, regulations, and policies established by statutory enactment or by the appropriate delegated authorities and should provide for appropriate penalties for noncompliance.

1.2.0 *Administrative Regulations*

In order to assure the planning, construction, continued maintenance, and safe operation of public drinking water supplies in the State, a legally constituted group or agency with appropriate statutory authority should be responsible for the regulation of drinking water in the State. The necessary authority to establish, amend, and enforce all necessary

rules and regulations that concern drinking water should be provided. These rules and regulations should be combined and published in a single document. The purpose and intent of this document should be to establish a uniform system of procedures and program activities to protect the public health.

1.2.1 *Drinking Water Quality Standards*

The regulations should require that all drinking water from public water supply systems in the State meet certain minimum drinking water standards adopted by the Administrator. The 1962 *Public Health Service Drinking Water Standards*[1] or the latest revision should be the basis for State standards. Some States have adopted these Standards as written, some use them officially and some unofficially. No State has adopted substantially different Standards. The Federal Standards should be considered as "minimum acceptable" standards, not as goals, by the States.

1.2.2 *Water Facility Design and Construction*

In addition to minimum water quality constituent limits and surveillance requirements, the PHS Drinking Water Standards include general criteria for water facilities and their operation. This is recognition that adequate facilities and a high level of operation are required to meet the minimum water quality requirements of the Standards. To supplement these general guidelines, the Environmental Protection Agency has published the *Manual for Evaluating Public Drinking Water Supplies*[2] to provide more detailed guidance to health and waterworks officials in determining whether a public drinking water system satisfies health requirements. Construction criteria contained in the *Manual* pertain to those features of a plant that are essential to the continued production of a safe water supply. The two publications cited are recommended as a guide for establishing minimum water facility operation and surveillance criteria but are not intended to supplant detailed water facility criteria considered necessary to meet local conditions.

1.2.2.1 *Minimum Design Standards*

The regulations should establish minimum design standards for water facility construction sufficiently detailed to meet the needs and requirements of the State. The minimum design standards should serve as criteria for the design and preparation of reports, plans and specifications for public water supply systems and establish a uniform system of design. The regulations should prohibit the start of construction until the preliminary studies and detailed plans and specifications have been received, found to satisfy the requirements of the minimum design standards and a permit or equivalent means of approval has been granted.

It is beyond the scope of this Manual to provide detailed criteria and requirements for the design of water supply facilities. The two EPA publications have been recommended as a guide for developing detailed design criteria. Another publication that may be useful is the EPA *Manual of Indidividual Water Supply Systems*.[3] Still another recommended publication is the *Recommended Standards for Water Works*[4] published by the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers. The latter is particularly recommended for use to supplement the three EPA publications since it provides detailed design criteria not contained in the other three publications. Together, these four publications should provide sufficient basis for the establishment of a State document on minimum design criteria and standards.

A comprehensive set of water facilities criteria will provide the basis for two important water supply program agency functions:

- Review of plans and specifications submitted by a licensed engineer.
- Provide the State engineers with the necessary criteria to use in conducting sanitary inspections of public water supplies. These criteria should be made available to engineering consultants as a basis for their design.

1.2.2.2 *Water Treatment Requirements*

The regulations should establish minimum acceptable water treatment requirements and require submission of data on water quality and quantity to enable assessment of the safety and adequacy of the water source in relation to current and reasonable future demands.

The water quality requirements of the *Drinking Water Standards* are minimum requirements, and good quality water should have physical and chemical characteristics considerably better than the limiting values established in sections 4.2, 5.1, 5.2, 6.1, and 6.2 of the Standards. For example, water with turbidity of 5 units and a color of 15 units may be acceptable; but in a coagulated and filtered water such values could indicate serious malfunctioning of the purification process. Similarly, increased concentrations of copper and iron could indicate a corrosiveness that would be objectionable to consumers, even though the concentrations of the metals did not exceed recommended limits. In well water, an increase in chlorides over the normal amount found in ground waters in the area may be the first indication of pollution.

The type of treatment required depends on the characteristics of the watershed or aquifer, the raw water quality, and the desired finished water quality. Treatment requirements have been established in the *Manual for Evaluating Public Drinking Water Supplies* and are given for three groups of water: those usable without treatment; those needing disinfection only; and those needing complete treatment. The regulations should provide as a minimum such treatment requirements that the finished water will meet the *Drinking Water Standards*.

1.2.2.3 *Preliminary Engineering Studies*

The regulations should provide for the submission of a preliminary engineering study on all proposed public water facility construction. Of particular importance is the investigation of:

- Adequacy of the source of supply both in terms of quantity and quality.
- Treatment requirements based on the water quality of the proposed source.

1.2.2.4 *Submission of Detailed Plans and Specifications*

The detailed plans and specifications should be prepared by an engineer licensed to practice in the State. They should meet minimum design standards adopted by the State and be reviewed and approved by the Administrator or the designated water supply program agency before a permit or approval for construction is issued.

1.2.2.5 *Inspection of Construction*

The engineering consultant should be required to provide inspection during construction to assure that all work is done in accordance with the State approved plans and specifications. The Administrator's representative should have access to the project at all times during construction.

1.2.3 *Surveillance of Public Water Supply Systems*

1.2.3.1 *Water Quality Sampling*

Bacteriological and chemical surveillance requirements should be specified for each public water supply.

- *Bacteriological*—A sampling program should be established that will provide for the examination of the water as it enters and flows throughout the distribution system. In establishing the frequency of sampling and the location of sampling points, consideration should be given to the water supply source, method of treatment, and storage and protection of the stored water. Samples should be taken at reasonably equal time intervals throughout the month. The minimum number of samples and frequency of sampling is contained in the *Drinking Water Standards* and is based on population served by a distribution system.
- *Chemical*—The purpose of sampling and analyzing drinking water for chemical and physical characteristics is to determine if the product being delivered conforms to the *Drinking Water Standards*. Compliance with the chemical and physical limits of these Standards should be based on the collection of a sample(s) that is representative of water quality in the distribution system.

1.2.3.2 *Supervision of Operation and Maintenance*

Regulations should provide standards and establish responsibility for the operation and maintenance of the treatment works and the storage and distribution system to the customer's free-flowing tap. The level of operational control should be specified for each class of public water supply based on the relationship between pollution loadings and extent of treatment required. Each water treatment facility should be operated to handle adequately any loading placed upon it.

All water quality tests should be made in accordance with the current edition of *Standard Methods for the Examination of Water and Waste Water*.[5] The schedule of laboratory tests needed to control the operation of a water treatment plant will vary with the volume and character of the water being treated. Tests for operational control should be conducted at least every 24 hours. Since turbidity and residual chlorine in finished water are valuable indices of the effectiveness of treatment processes, these tests should be made often, sometimes at hourly intervals when the quality of the raw water is changing rapidly.

Complete records should be maintained by the utility and the regulations should provide for submission of monthly water system operating reports to the State water suppl program agency for review.

1.2.3.3 *Laboratory Services*

All laboratories in the State (water plant, municipal, district, regional and commercial) engaged in the analysis of samples for compliance with the *Drinking Water Standards* should be evaluated at a specified minimum frequency (3 years is suggested) and certified to upgrade sampling and analytical techniques. Only data from certified laboratories should be acceptable for official use in monitoring the public's drinking water. The PHS publication, *Evaluation of Water Laboratories*, 1966,[6] is recommended as a guide for evaluating water bacteriological laboratories. This guide is used as a basis for EPA evaluations of State laboratories engaged in the analysis of drinking water samples collected from interstate carrier water supplies. Traditionally, the Public Health Service (and now the EPA) has approved the State laboratories, which in turn, through qualified State laboratory survey officers, certify laboratories at the local level.

The regulations should provide the State program agency with the authority to approve laboratory methods relating to sample collection and laboratory analysis procedures. Procedures generally acknowledged by the scientific community to be the best available are contained in the current edition of *Standard Methods for the Examination of Water and Wastewater*. Procedures contained in this publication have received legal acceptance at all levels of State and Federal court systems.

1.2.3.4 *Cross-Connection Control*

Cross-connections in plumbing systems and in public drinking water supply systems continue to be a serious hazard to water supplies and only constant vigilance in their detection and elimination can reduce the ever present risk of contamination from these sources. Effective cross-connection control regulations should be established; however, the responsibility for the surveillance and enforcement of these regulations should be carried out at the local level. The thrust of the regulations should be to encourage and support the enactment of local programs of backflow prevention and cross-connection control. These programs may be the responsibility of owners and managers of public water supply systems, local plumbing inspectors, or the local health department.

The following provisions are suggested as basic elements of effective cross-connection control regulations:

- Provide for the establishment and implementation of an effective cross-connection control program for all public water supply systems.
- Prohibit the installation and maintenance of:
  - — Water service to any premise where actual cross-connections exist.
  - — Any connection where water from a non-potable auxiliary water system may enter a potable water system.
- Provide for the entry of authorized personnel to any premise served by a public water system for the purpose of making surveys and investigations for cross-connections.
- Provide for the installation of backflow prevention devices where they are deemed necessary and provide that the type of device required be based on the nature and the degree of the hazard.
- The use of backflow prevention devices approved for use by an agency designated by the Administrator.
- Provide criteria for booster pump installation in public water supply systems and on premises served by public water supply systems.
- Provide for penalties, including possible discontinuance of water service, to anyone in violation of the cross-connection control regulations.

1.2.3.5 *Bottled Water*

Regulations should require that all bottled water meet the bacteriological and health related chemical constituent limits of the *Drinking Water Standards*. Surveillance and enforcement of these Standards may be the function of the State water supply program, the State food and drug authority, or other State agency.

1.2.4 *Operator Certification*

Competence in operating ability is essential for the protection of public health and the maintenance of reliable operation. Operation of

water supply systems must rest in the hands of qualified persons. Skilled operation not only safeguards the public health and offers the degree of protection to which the consumer is entitled, but also protects a community's investment in its drinking water facilities.

Regulations should provide for mandatory certification of the technical competency and overall capability of water utility operator personnel. Currently, there is some type of a certification program in almost all of the States. The majority of the States make certification of water utility operators mandatory. Oftentimes, the number of eligible operators certified under a voluntary program is small.

The legal basis for certification should be provided by either statute or regulation, preferably by statute. Responsibility for the administration of the certification program should be specified, i.e., State department or agency, a board, committee, etc. While it may be desirable to have an advisory or examining board, the major decision making responsibilities of the certification program should reside with the water supply program agency. If the program is part of either the health department or environmental agency, with a certification board serving officially in an advisory capacity, the board's stature should be such that its recommendations will be respected by the State agency.

1.3.0 *Water Supply Policy*

Program policy frequently becomes established by official correspondence, program agency publications and documents. It should be recognized, however, that program policy may not be subject to the legal enforcement provisions of the State code. Many of the regulations recommended in this section exist only as program policy in many States and have not been formally adopted as regulations. A determination should be made, for the State under evaluation, of the legal status of policy. This will influence recommendations to formally establish certain policy items as regulations.

An important consideration is to determine how policy is established and utilized by the water supply program agency. Too often, policy is loosely divided among a number of publications and documents issued by the program agency. In a number of instances, policy may exist merely as an understanding between the agency and the water works industry. All water supply policy should be integrated and compiled into a single water supply policy document and made available to all industry groups or individuals on request. The document should be updated periodically as policy revisions occur.

Section 2 WATER SUPPLY PROGRAM ACTIVITIES AND RESOURCES

The State organizational structure should be reviewed and the principal water supply agency examined in context with other environmental and natural resource programs within the department or within other departments of State government. This should be done for the purpose of determining the visibility and organizational structure of the water supply agency in relation to other environmental programs. All other activities related to drinking water outside the responsibility of the principal water supply agency should also be evaluated.

Water supply activities are occasionally divided among a number of State agencies and the responsibilities for some activities often parallel or duplicate those delegated to the principal agency. Each agency should be identified and its specific areas of responsibility examined for overlap with others. If this process reveals an unnecessary duplication of effort or important areas of responsibility not covered it may be desirable to reorganize activities or reassign responsibilities for more efficient and effective utilization of resources.

There is a compelling reason for a fresh and objective review of a State water supply organization. The last decade has seen a rapid evolution of environmental programs. Programs in wastewater, air pollution, solid wastes, pesticides, radiation, occupational health, etc., have either been created or significantly enlarged by the State governments. Some of these programs have affected the older more established drinking water programs in a number of ways. Public awareness and a desire to deal with neglected environmental problems has often led to crash funding and priorities that may have diminished the visibility and relative importance of the water supply program as a part of the total environmental effort. In addition, many of these programs relate to water supply activities in varying degrees. New laws, regulations and State agency policies promulgated for the establishment of these programs may have created overlapping responsibilities and unnecessary duplication of effort. Significantly, the environmental effort has grown to such proportions that many States have reorganized their Departments of Health and Natural Resources and created departments or agencies that deal only with environmental problems.

There is no single organizational approach that will work equally well for all States. A review of the existing structure and function, supplemented by discussions with State personnel at various levels, will

frequently identify possible means to improve the structure or develop improved coordination of activities.

The principal activities of a State water supply program are:

- Engineering surveillance and technical assistance
  - — Thorough periodic sanitary inspections of existing public water supply systems
  - — Water facility construction surveillance including review of preliminary engineering studies, plans and specifications
  - — General technical assistance to support water supply activities of other State agencies, local health departments and Federal agencies
  - — Water supply planning for normal and emergency use
  - — Participation in reporting waterborne diseases
  - — Critical evaluation and management of water supply data
  - — Enforcement of water supply statutes and regulations
- Bacteriological sampling of each public water supply
  - — At a level of frequency no less than that prescribed by the *Drinking Water Standards*
  - — Procedures to assure immediate resampling and follow up when unsatisfactory bacteriological results are encountered
- Routine chemical analysis of all public water supplies
- The reliability of laboratory analysis
  - — Acceptance of water sample analysis only from those laboratories that have been evaluated and certified by the State.
- Operator certification and training to insure that drinking water supply facilities are in the hands of qualified persons.

One objective of a water supply program evaluation is to determine the resources necessary for the State to conduct an effective drinking water program. Over the past few years, the Environmental Protection Agency has developed various estimates to represent the costs to the States for conducting effective surveillance, training, and technical assistance activities to insure the safety of water supply systems serving the public. The resulting estimates have varied widely due to the use of different definitions of a "public water supply system"; the lack of an accurate inventory of water supply systems; and the lack of an agreement on the substance and unit costs of surveillance for a typical public water supply system. This section of the manual has been developed on best current estimates available. The methods used and the basic assumptions made are included to provide the reader with a rationale for determining program costs for a particular State.

State community water supply program costs are estimated based on the following fundamental elements of a program's activity:

- Surveillance
  - — Engineering surveillance and related technical assistance

— Chemical surveillance
— Laboratory certification
— Bacteriological surveillance
- Training
  — State personnel staff
  — Water utility operators
- Program administration

2.1.0 *Engineering Surveillance and Technical Assistance*

2.1.1 *Surveillance of Water Supply Facilities*

2.1.1.1 *Sanitary Surveys of Water Supply Systems*

Criteria for public water supply surveillance is provided in the EPA *Manual for Evaluating Public Drinking Water Supplies* as well as the *Drinking Water Standards*. Section 2.2 of the *Drinking Water Standards* provides that, "Frequent sanitary surveys shall be made of the water supply system to locate and identify health hazards which might exist in the system." Although the frequency of inspection is not specifically stated and will vary depending on the nature of the system, it is suggested that an annual engineering inspection and field survey should be conducted for each public water supply system. This should be supplemented by follow-up visits to correct specific problems.

In evaluating the health risk of a water supply system, it is suggested that as a minimum the following ten areas of the system receive careful and critical examination:

- Quality of source
- Quantity of source
- Protection of source
- Adequacy of treatment facilities
- Adequacy of operation
- Distribution system storage
- Distribution system pressure
- Chlorine residual in distribution system, where appropriate
- Quality control—records and tests
- Quality control—cross-connection control.

2.1.1.2 *Construction Surveillance*

This activity of a State water supply program concerns the review of preliminary engineering feasibility studies and the review of construction plans and specifications for all new water facilities as well as modification of existing facilities. Approval of new water facility construction should also include the approval of the source of supply. Existing problems can be expeditiously corrected, and even more important from a long-range standpoint, problems can be prevented in new systems and system modifications through a strong construction surveillance program. A water facility construction permit, or an

equivalent means of approval, should be issued only after a preliminary engineering report and the plans and specifications have been received and found to meet the minimum design and criteria requirements of the rules and regulations.

2.1.1.2.1 *Preliminary Engineering Studies and Source of Supply*

An essential element of a preliminary study is the determination of the adequacy of both the quantity and quality of the water supply source. Water quality and quantity data should be assembled to allow assessment of the adequacy of the water source in relation to current and reasonable future demands. A careful evaluation of the source of supply is critical to the later review of plans and specifications since the design of plant facilities, unit processes, etc., is largely based on the quality and quantity of the source. Section 2.1 of the *Drinking Water Standards* states, "If the source is not adequately protected by natural means, the supply shall be adequately protected by treatment." *The Manual for Evaluating Public Drinking Water Supplies* includes more detailed consideration of sanitary requirements for water source protection and is recommended in addition to the *Drinking Water Standards* as a guide in evaluating sources of drinking water supply.

A review of preliminary studies can also be a means to reduce the proliferation of small systems. Instances may be found where interconnections with an existing system were not adequately considered.

2.1.1.2.2. *Review of Plans and Specifications*

The water supply program agency should provide a thorough and comprehensive review of all plans and specifications for construction of new drinking water facilities and modification of existing facilities. The State should have available a comprehensive compilation of water facility criteria and standards that will provide the basis for the review of plans and specifications submitted by the engineer. The detailed plans and specifications should be prepared by an engineer licensed to practice in the State.

2.1.1.3 *Special Surveillance Activities*

Although cross-connection control, fluoridation and the regulation of bottled water quality can be considered a part of normal surveillance activities, they are given separate consideration because of the special character of the activities.

2.1.1.3.1 *Cross-Connection Control*

The objective of this program activity should be to encourage and support the enactment of local programs for backflow prevention and cross-connection control by owners and managers of public water systems.

Cross-connections are serious water system deficiencies which have

been documented as causing the spread of dangerous waterborne diseases, chemical poisonings and deaths. Most communities do not have effective cross-connection control programs and much needs to be done in the areas of public awareness, training, inspection, and correction of these hazards.

The judgement of the effectiveness of a State cross-connection control program can be based upon:

- The success in implementing the cross-connection control regulations described in Section 1 and the degree to which local programs are promoted and supported.
- The extent to which cross-connection control programs are established and enforced at the local level.
- The scope and effectiveness of education and training provided by the State.

The overall effectiveness of a control program in any field is dependent upon the support of the local governing and administrative officials. A program of health education for the general public in this field would serve a useful purpose. A prerequisite to good control, however, is the stimulation of equipment manufacturers, inspection and construction personnel, and water utility maintenance personnel to a realization of the importance of these types of water system defects. A positive educational and training program at the State level is vital to the establishment of an effective cross-connection control program.

2.1.1.3.2 *Fluoridation*

Where fluoridation is practiced, and particularly in those States with mandatory fluoridation requirements, the water supply program has the responsibility for: establishing criteria for the design, installation, and operation of the equipment; review and approval of plans; and the surveillance of the fluoridation installation after the system is placed in operation.

The actual level of fluoride ion in the distribution system is the single most important factor in evaluating the adequacy of a community water fluoridation effort and check samples should be submitted to the State for fluoride ion analysis on a regular basis. Distribution system samples collected on any one particular day, however, may not give a true picture of day-to-day conditions and these installations should receive periodic inspections at least annually by representatives of the State water supply program agency.

In addition, monthly operation reports submitted to the State should include the results of daily analysis of fluoride ion content of the finished water, periodic analysis of the raw water and daily calculations of the theoretical fluoride ion level based on the quantity of fluoride fed to the volume of water treated.

2.1.1.3.3 *Bottled Water*

Bottled water should comply with the same health related constituent

limits and monitoring requirements of the *Drinking Water Standards* that are applicable to all other public drinking water supplies. Surveillance and enforcement of the Standards may be the function of the State water supply program agency, the State food and drug authority, or other agency of State government.

A review of the State water supply program activities should determine if the water supply program is responsible for the regulation of bottled water, and, if not, where the responsibility is placed. It should further be determined if the responsible agency has an established surveillance and enforcement program to insure that bottled water is meeting the requirements of the *Drinking Water Standards*.

2.1.2 *Technical Assistance*

The principal water supply agency may provide engineering and technical assistance in a variety of ways. Often when water supply responsibilities are divided among a number of State or local agencies the principal water supply agency provides advisory service and support for the activities. Some of these activities may include small public water supplies under the administrative responsibility of the State sanitarians or local health departments. Another activity to which the agency may lend its support and assistance is bottled water. The agency may be involved in Federal grant and loan programs for the construction of water supply facilities. These activities can be time consuming and significantly reduce the agency's effort in other areas.

2.1.3 *Planning*

In light of the proliferation of small, underdesigned, and poorly operated systems in some areas, it is desirable for the State water supply program agency to encourage the orderly development of public water supply systems.

The problem of small water systems is believed to be common to most States. Small systems have trouble paying for the basic plant, equipment, supplies and operation which would enable them to meet minimum quality standards. Their large numbers also present a burden to the State sanitary engineers who must provide a program for their regulation and sanitary control. Their job is compounded because the majority of water utilities that the State must oversee provides services to relatively few consumers.

Where possible and economically feasible, the physical and/or managerial consolidation or regionalization of existing small water systems into a larger, more viable single unit is a definite advantage to be actively sought and promoted by the State.

The State water supply program should include the following areas of planning activity:

- Acquisition and periodic review of comprehensive area land use and development plans

- The active promotion of consolidation or regionalization of existing small water systems where possible or economically feasible
- A review of preliminary engineering studies to determine the feasibility of consolidation
- Strict requirements on the design, construction and operation of small systems to discourage their proliferation
- Emergency measures and mutual aid for supplies and equipment
- Alternative energy needs and priorities.

2.1.4 *Waterborne Disease Reporting*

During the 25-year period, 1946–1970, there were 356 known waterborne disease outbreaks in this country.[7,8,9] Currently, about 14 waterborne disease outbreaks occur each year.[7] These outbreaks cause on the average, 1600 illnesses and one death per year.

It has been the custom of the State health departments to report the unusual occurrence of any disease to the National Center for Disease Control (NCDC) and this constitutes the primary source of information about waterborne outbreaks. Officially reported outbreaks[7,8,9] are those reported to NCDC. However, additional outbreaks have been found by other means: (1) a review of the medical and engineering literature; (2) newspaper and newsletter clippings; (3) a survey of the State sanitary engineers and State epidemiologists; (4) data from the Division of Indian Health, U.S. Public Health Service. It is estimated that only slightly more than half of the outbreaks occurring since 1956 have been reported.[7,8,9] The investigation of outbreaks is often incomplete and conducted long after the outbreak occurs; consequently, relatively few outbreaks can be considered as proven to have been caused by the drinking water.

There are a number of ways that a State can improve the detection, investigation, and reporting of waterborne disease:

- Establish an epidemiological team to investigate suspected waterborne disease outbreaks.
- Establish a cooperative agreement among State, county, and local agencies that are involved in such activities as food and drug regulation, and restaurant and milk inspection to centralize reporting of disease outbreaks.
- Establish an agreement with the State medical association to report the occurrence of selected diseases related to drinking water.
- Computerize data for storage and retrieval on all known waterborne disease outbreaks, suspected waterborne disease occurrences, all investigations, etc.

2.1.5 *Data Management*

An immense quantity of data must be collected, evaluated, and filed for the successful management of a water supply program. Information on bacteriological and chemical surveillance, engineering inspections,

and monthly water system operating reports for community water supply systems is essential. In addition, surveillance data on other public water supplies is necessary and must receive some degree of review by the water supply programs office.

A large number of the informational items mentioned above should be retained and be continuously available for reference or analysis. Assuming a State has several hundred community water supplies, informational items can run into the millions. Data for the other public water supplies will increase this number considerably. The portion of this data requiring systematic storage and retrieval availability could best be handled with automatic data processing techniques. Automatic data processing would provide an effective means to evaluate water supply data, summarize information on a Statewide basis, and identify problems. Automatic equipment can perform these important screening and summarization functions, allowing the professional staff to concentrate on problem areas and remedial action.

2.1.6 *Engineering Surveillance and Technical Assistance Cost Estimates for Community Water Supply Systems*

A practical and convenient approach to developing program cost estimates for engineering surveillance activities is to define the cost of these activities in terms of an average surveillance cost per water supply system. The form in Appendix C is provided in order that costs can be estimated that will reflect the local conditions for an individual State. In general, however, the cost estimate for engineering surveillance and technical assistance may be based on the following assumptions:

- *Four (4) man-days* will be required on the average per supply for the following activities:
  - — Sanitary surveys of existing systems including informal on-the-job training
  - — Construction surveillance
  - — General technical assistance
  - — Waterborne disease investigations
  - — Planning
  - — Data management.
- Average annual estimated personnel costs for surveillance: $20,000.[a] (includes salary, fringe benefits, travel, office supplies, office space and one-third man-year secretarial support.)
- 220 man days equals 1 man year.

On this basis, one man-year of effort can provide surveillance over 55 systems per year.

$$\frac{\text{220 man-days per year}}{\text{4 man-days per system}} = \frac{\text{55 systems}}{\text{year}}$$

[a] This figure is an estimate based on the best current information available. Since the figure is subject to significant change, revised estimates should be made based on up-to-date information for the particular State under evaluation.

The average surveillance cost per system will then be approximately $360 per year.

$$\frac{\$20{,}000 \text{ per year}}{55 \text{ systems per year}} \cong \$360 \text{ per system}$$

2.2.0 *Bacteriological Surveillance*

Criteria contained in the *Drinking Water Standards* and the *Manual for Evaluating Public Drinking Water Supplies* are recommended for use in evaluating the bacteriological surveillance of public drinking water supplies. The number of samples and frequency of sampling is contained in the *Drinking Water Standards* and is based on population served by a distribution system.

Bacteriological monitoring should be considered to be an operational procedure to be performed at the expense of the water utility; however, the State is responsible for performing a minimum number of analyses to assure itself that the analyses by the water utility are properly performed. The State program should provide bacteriological surveillance sufficient to check laboratory analysis conducted by and for public water supplies and, in the case of systems without laboratory capability, bacteriological surveillance sufficient to meet the Standards. The State should undertake periodic surveys of laboratories (at least triennially) and continually compare State laboratory results with the results furnished by the utilities.

It is recommended that the State examine monthly from each system 5 percent of the distribution system samples required by the *Drinking Water Standards* or two samples, whichever is greater. The number of distribution samples required can be obtained from Figure 1 in Section 3 of the *Drinking Water Standards*.

For bacteriological samples showing contamination in 3 or more of 5 fermentation tubes (10 ml) or a membrane filter count of 5 or more coliforms per 100 ml, daily check samples should be collected from the same sampling point until the results from two consecutive samples show the absence of coliform bacteria. Concurrently, immediate action should be taken to locate and correct the cause of the contamination. It is particularly important that elapsed time between determination of contamination by the laboratory and notification of the supply that resampling is necessary be kept as short as possible. This requires telephone notification rather than mail service. Preferably, resampling should begin the same day laboratory results become available. This requires close communication between the water supply program office and the laboratory.

Review of bacteriological laboratory results and a systematic procedure to examine and record bacteriological data from the State and the

water utility laboratories should be provided by the program office. Failure to review results reported from the laboratory or a review of results performed sporadically and in an unsystematic manner can allow serious bacteriological problems to go undetected and uncorrected.

2.2.1 *Bacteriological Surveillance Cost Estimates*

The following bacteriological analytical costs, to the States, are developed on the following assumptions:

- Cost per bacteriological analysis—$2.50 per sample.
  Cost of sample bottle, mailing container, labels and postage—$2.50 per sample.
  Total cost = *$5 per sample.*
- State to examine monthly from each system 5% of the distribution samples required by the *Drinking Water Standards* or two samples, whichever is greater. On this basis, the State would examine two samples from each system serving fewer than 35,000 people and 5% of the required number for all larger systems. Refer to Figure 1 in section 3.1 of the *Drinking Water Standards* for the required number of bacteriological samples per month.
- Costs are developed for systems serving three population size groups. The estimated percent of systems in each size group is based on data from the last national inventory of municipal water facilities compiled by the U.S. Public Health Service in 1963.

System Size	*Percent of Systems*
35,000 or less	95
35,000–100,000	3
100,000 or larger	2
	100

Sample Calculation: The average size system in the 35,000–100,000 range was estimated at 67,500. The required number of bacteriological samples for this system is 80 (refer to Figure 1, Section 3.1 of the Drinking Water Standards). Five percent of the required number is 4 per month per system or 48 samples per year. At a cost of $2.50 per sample for analysis the estimated manpower need for bacteriological surveillance is:

$$\frac{\$2.50 \text{ per sample} \times 48 \text{ samples per system per year} \times 220 \text{ man-days per year}}{\$20{,}000 \text{ per man-year}}$$

$$= 1.32 \text{ man-days per system per year}$$

At a total cost of $5 per sample, the annual cost of bacteriological surveillance for an average system in this size group would be $240.

TABLE 2.2.1—*Bacteriological Cost Estimates*

Population Served	Samples Per Month per System	Samples/Year per System	Manpower Need (Man-days) Per System Per Year	Average Cost Per System Per Year at $5 per Sample
<35,000	2	24	.66	$120
35,000–100,000	4	48	1.32	240
>100,000	10[a]	120	3.30	600

[a] based on an average population of 375,000

2.3.0 *Chemical Surveillance*

The principal features of a chemical surveillance program are:

- A program policy that specifies the frequency and type of chemical determinations for each public water supply.
- An adequately equipped and staffed laboratory to handle the number of chemical analyses specified.
- Record keeping procedures to assure continual updating of the files and facilitate a systematic check of the date and type of previous chemical analysis.
- An action program designed to eliminate the hazard when health limits for chemical constituents are exceeded.

The purpose of sampling and analyzing drinking water for chemical and physical characteristics is to determine if the product being delivered conforms with the *Drinking Water Standards*. Compliance with the chemical and physical limits of these standards should be based on the collection of a sample(s) that is representative of water quality in the distribution system.

As a minimum, a complete chemical analysis should be made annually for surface supplies and triennially for ground water supplies. These analyses should include all the physical and chemical constituents listed in the *Drinking Water Standards*. In addition, all community water supplies should be examined for radiochemical constituents listed in the *Drinking Water Standards* on a triennial basis.

This chemical monitoring criteria is based on the *1962 PHS Drinking Water Standards* and EPA Water Supply Division guidance. The *Drinking Water Standards* are currently under revision. A change in the chemical monitoring criteria under consideration is outlined in Appendix B.

It is recognized that a large number of water utilities do not have the capability to make some of the more important health related analyses listed in the *Drinking Water Standards*. Where it is not feasible for this capability to exist, the State should assume responsibility for sufficient

sampling and analysis to insure that water of satisfactory chemical quality is delivered to the consumer by the public water supply system.

2.3.1 *Chemical Surveillance Cost Estimates*

The following estimate of chemical surveillance costs considers:

- The minimum elements of a chemical analysis considered sufficient to determine the health related chemical and physical quality of a drinking water.
- The number of man-days required to analyze each sample.
- The minimum frequency of monitoring for each element of the chemical analysis based on the type of water source. (It is assumed that 20 percent of community water supplies use surface sources and the remaining 80 percent use ground water sources.)

TABLE 2.3.1—*Chemical Analysis for Drinking Water*

Chemical Analysis	Man-Days Analysis Per Sample	Surface Water Sources		Ground Water Sources	
		Frequency of Analysis	Man-Days Per Annum	Frequency of Analysis	Man-Days Per Annum
Wet Chemistry	0.65	Annual	0.65	Triennial	0.22
Trace Metals	0.65	Annual	0.65	Triennial	0.22
Pesticides (chlorinated hydrocarbons and herbicides)	2.00	Annual	2.00	—	—
CCE	1.00	Annual	1.00	—	—
Radiochemical	1.20	Annual	1.20	Triennial	0.40
TOTAL	5.50		5.50		0.84

Manpower Requirements:

Estimates are based on the assumption that 20 percent of community water supplies use surface sources and the remaining 80 percent use ground water sources. The estimates also assume one complete chemical analysis per year for surface supplies and one triennial analysis for ground water supplies.

Surface Water Sources:
5.50 man-days/year/analysis × 20% ≅ 1.10 man-days/system/year
Ground Water Sources:
.84 man-days/year/analysis × 80% ≅ 0.67 man-days/system/year
Total Manpower Requirement: 1.77 man days/system/year
Cost Estimates:

Surface Water Sources:

$$\frac{1.10 \text{ man-days/system/year} \times (\$20{,}000/\text{year})}{\frac{220 \text{ man-days}}{\text{year}}} \cong \$100/\text{system/year}$$

Ground Water Sources:

$$\frac{0.67 \text{ man-days/system/year} \times (\$20{,}000/\text{year})}{\frac{220 \text{ man-days}}{\text{year}}} \cong \$61/\text{system/year}$$

Total Cost ≅ $161/system/year

2.4.0 *Laboratory Support Services*

Laboratory support capability is a vital element in a State water supply program. The laboratories should be sufficient in number and staff and equipment to handle the number of bacteriological and chemical samples specified in the preceding sections and geographically spread for minimum bacteriological sample travel time.

2.4.1 *Laboratory Evaluation and Certification*

Evaluation and certification of all laboratories examining the bacteriological and chemical quality of drinking water is considered necessary for the proper operation of a water supply program. According to statistics furnished by State Health Laboratories, approximately 3.5 million potable water samples are examined each year. To produce reliable data, it is essential that approved laboratory methods be adopted in all laboratories which monitor this nation's public water supplies.

A major portion of the *Drinking Water Standards* relate not only to water quality but also to laboratory methods and technical competency of laboratory personnel. Section 3.13 of the *Drinking Water Standards* states that bacteriological results may be accepted from the laboratories of the reporting agency (usually the State Health Department), local government laboratories, water works authorities, and commercial laboratories, but only when these laboratories have been approved for use by the reporting agency and the certifying authority (EPA). Traditionally, EPA has approved the State laboratories, which in turn, through qualified State laboratory survey officers, certify the laboratories of local health departments, water works authorities, and commercial establishments.

The goal of the State evaluation and certification program should be to upgrade techniques and procedures in all laboratories engaged in drinking water analysis so their data are acceptable for official use in monitoring public water supplies. At the present time, data being generated by many laboratories is poorly utilized in part because of the uncertainty of its quality. Thus the State laboratory service is burdened with the complete monitoring requirements for all official samples examined per month for these public water supplies.

The basic purpose of a laboratory evaluation is to extend technical consultation that will lead to improvements in overall service and

reliability of data. Each procedure or item of critical equipment should be examined in detail for compliance with "Standard Methods" procedures. The survey officer must view the laboratory evaluation as a conference on approved methods and procedures. The publication, *Evaluation of Water Laboratories*,[6] has been written as a guide for use in conducting a bacteriological water laboratory evaluation. The guide contains recommended procedures on sample collection and analysis, laboratory equipment and materials, a sample survey form and recommendations for reorganization of laboratory services.

The optimum frequency of laboratory evaluations at the State level appears to be once every three years. Experience indicates that visits at more frequent intervals yield little value to either the staff or the program while longer intervals result in an increased number of deviations observed. Obviously, where there are major difficulties or a large turnover of laboratory personnel, evaluations must be performed more frequently depending upon the individual situation

2.4.2 *Laboratory Surveillance Costs*

It will be necessary to certify on a triennial basis all laboratories used by the utilities for bacteriological and chemical analysis.

2.4.2.1 *Certification Costs for Bacteriological Laboratories*

For the purpose of estimating a cost for this activity, State bacteriological laboratories can be grouped into two size classifications: (a) large district or regional State laboratories; and (b) small laboratories; county or local health departments, commercial, and water utilities. The following cost estimates for certification of laboratories is based on EPA laboratory certification experience in the States.

Cost estimates for certification of bacteriological laboratories are based on the following assumptions:

- 5 man-days required per regional laboratory for survey preparation, travel time (one day to site and return), site visit, and report preparation.
- 3 man-days required per small laboratory for the same activities as described above.
- 220 man-days equals one year.
- Personnel costs:
  - Assume $15,000 average salary for certification officer

$$\frac{\$15{,}000}{220} \cong \$68 \text{ per day}$$

  - Assume $7,500 for secretary

$$\frac{\$7{,}500}{220} \cong \$34 \text{ per day}$$

  - Assume $40 per day for travel and per diem

Cost for certification of regional laboratory

- $68/day × 5 days professional—$340 per survey
- 3 days per diem and travel—$120
- $34/day × ½ day secretary—$17
- Total = $477

Certification costs for regional laboratory certification is approximately $477 every 3 years or *$159 per year*.

Annual manpower requirement for certification of regional laboratory: 5½ man-days every 3 years of *1.83 man-days* per year.

Cost for certification of small laboratories

• $68/day × 3 days professional	—	$204
• 2 days per diem and travel	—	80
• $34/day × ½ secretary	—	17
Total		$301

Certification costs for small laboratory certification is approximately $301 every 3 years or *$100 per year*.

Annual manpower requirement for certification of small laboratories—3.5 man-days every 3 years or *1.17 man-days* per year.

2.4.2.2 *Certification Costs for Chemical Laboratories*

In general, only the large State regional or district laboratories are staffed or equipped to analyze drinking water samples for the constituents of a wet chemistry, trace metals or pesticide sample. Occasionally the water utility laboratory of a large metropolitan system may have this capability but these laboratories are exceptions and there may be no more than a few in a State. For this reason, unlike the preceding bacteriological laboratory certification estimates, certification costs are applicable only for the large regional, district or metropolitan laboratory.

The small water utility laboratories should be equipped to conduct physical and chemical analyses for operational control. The capability and test procedures of these laboratories should be examined and evaluated by State program agency personnel during routine sanitary surveys of the utility.

Based on EPA experience with the certification of chemical laboratories, the cost of laboratory evaluations are quite similar to the cost for evaluating and certifying the large bacteriological laboratory. For this reason, the cost of State evaluation and certification of chemical laboratories is estimated to be approximately $477 every 3 years or $159 annually.

2.5.0 *Operator Certification and Training*

The operation of drinking water supply facilities must rest in the hands of qualified persons. This is becoming more important each year as improving technology in water treatment increases the complexity of

operational requirements and the public demand for improved water quality and service increases. The establishment of a program to achieve a high standard of operational performance should be a first-level objective of a State water supply program. Mandatory certification, short schools, correspondence courses, courses in junior colleges and vocational schools, and frequent visits by competent regulatory agency personnel are all part of a good program.

2.5.1 *Certification*

Certification should be available to all operators of water treatment plants and water distribution systems who can meet the minimum qualifications of a given classification. Certification should insure that every operator in responsible charge of a water treatment plant or a water distribution system holds a certificate in a grade equal to or higher than the grade of his treatment plant or distribution system. In addition to a technically qualified chief operator (or manager) the water plant and distribution system should also be staffed with an adequate number of competent (preferably certified also) operators and maintenance men qualified to handle the operations in the absence of the chief operator or during any type of emergency situation.

The level of certification required for water treatment operators and distribution system personnel should be based on the size of system (population served) and/or the type and extent of treatment provided. This requires the development of a classification system for facilities.

Certificates should be issued in a comparable classification without examination to any person who holds an operator's certification from any State, territory or possession of the United States or any country if, in the judgement of the certification board, the requirements for certification of operators under which the person's certification was issued do not conflict with the requirements of their program and are of a standard not lower than the requirements of their program.

2.5.2 *Training*

The education and training of water utility personnel is fundamental to a successful certification program. Education and training needs should be identified separately. Too often training is emphasized at the expense of education. The professional needs in water supply facilities management cannot be met through training alone. Training and educational programs should be available for professional regulatory personnel, utility management and supervisory personnel, and water facility laboratory and operating personnel.

Many types of training are available. In general, the basic role of the 2- and 4-year colleges are educational and that of the trade and vocational-technical schools are training. Courses at vocational schools and junior colleges may vary in length from a few weeks or months to two years and may be conducted on the basis of forty hours a week.

Frequently, night courses are made available through these institutions. Many of the courses taught at vocational training schools and junior colleges are at the entry or beginning level and do not provide training for the upper levels of certification thus requiring personnel who desire to prepare for the higher levels of certification to take correspondence courses. Correspondence courses appear quite attractive to those that are capable of working and studying on their own.

Many States provide or support operator training by conducting a number of "short courses." These courses have, for the most part, been designed to review existing knowledge and make available information concerning new developments.

It may be necessary to encourage State educational institutions and private concerns to develop basic training courses for the operator. Certain unique characteristics exist in the water supply field that engender special training needs. Basic courses in the sciences and engineering that are water supply oriented are not always available at educational institutions. It may require cooperative efforts of the State water supply program agency, the State Department of Education, and the private and commercial educational institutions to ensure the availability of a viable education and water supply training program.

Although many States provide or support operator training by sponsoring and conducting a number of training courses, it is suggested that the basic responsibility for operator training reside with the water utility and the operator. This approach to training is also supported by the American Water Works Association.[10]

The suggested approach to a training program is that the utility and operator should be responsible for entry-level operator training such as basic skills in mathematics, water chemistry and microbiology and water plant operations and unit practices. The State should provide for short-term training courses to update operator skills in new water supply practices and to acquaint personnel with State regulations and requirements, etc. The State water supply program agency can also support and encourage efforts at the local level by an evaluation of training needs in the State, dissemination of information to the utilities on available water supply training and the costs involved.

Probably the single most important and effective action that the State water supply program can employ that will improve operators and plant operation is the in-plant training and assistance that is normally given during regular inspection and technical assistance visits to the utility. The State engineer or professional conducting the inspections or visits should be training oriented and tactful in pointing out deficiencies and suggesting improvements. Properly accomplished, such visits are a powerful force for operator improvement and, hence, operations improvement.

2.5.3 *Training Costs*

State Staff—Assume that each professional should receive an average of 5 days training per year. The cost is estimated at $100 per day or $500 per year based on:

- $60/day—the rate EPA charges for courses
- $40/day—travel and per diem costs

Based on prior assumption that each professional will provide surveillance over 55 systems per year, the cost is

$$\frac{\$500}{55} \cong \$9 \text{ per system per year}$$

Operators—State costs for operator training are based on the following assumptions:

- The utility and/or operator should be responsible for the cost of entry-level operator training such as basic skills in mathematics, water chemistry, microbiology, water plant operations, and unit treatment practices.
- The State will provide and absorb the cost for short-term training courses to update operator skills in new water supply practices, to acquaint personnel with State regulations and requirements, etc. It is also assumed that one operator per system should receive one day training per year.

On this basis, the cost will be $60 per system per year. The $60 cost is the cost to the State for providing the training based on EPA rates.

Total training costs per system per year = $9 + $60 = $69.

Based on an annual personnel cost of $20,000 per annum, this level of training requires:

$$\frac{\$69 \text{ per system per year} \times 220 \text{ man-days per year}}{\$20{,}000 \text{ per year}} =$$

.76 man-days per system per year

2.6.0 *Program Administration*

The administration of a water supply program includes a number of key activities. Administrative and management activities will involve a considerable portion of the cost for conducting a program. The principal functions of program administration are efficient management and planning for a comprehensive state-wide water supply program.

2.6.1 *Program Supervision and Water Supply Authority*

Administrative and management elements of a State program will include:

- Development and coordination of program activities
  - — Develop and implement program policy
  - — Develop staffing and budget needs

— Provide program direction and supervision.

- Development of basic water supply legislation and rules and regulations including standards, criteria and guidelines
  — Review and revise existing laws
  — Analyze and testify on proposed legislation
  — Develop and promulgate standards, criteria and guidelines.

2.6.2 *Cost of Program Administration*

The direct costs of program administration will include items such as salaries and travel for personnel engaged in activities outlined in the preceding section. Indirect costs, however, may add significantly to an agency's budget. Costs will vary significantly depending on the accounting methods used for centralized services such as rent, utilities, and maintenance, and personnel, accounting and purchasing services. All or a portion of these administrative support services may be charged to a general fund or to the water supply program budget.

It is believed that a sound guideline for administrative manpower requirements would provide for a director plus one supervisor for every 10 employees plus one additional supervisor for 20 or more employees. The latter provision takes into account the need for a deputy or assistant director when the staff numbers 20 or more. In addition, one clerical position is needed for every three supervisory positions. Therefore, for a staff of 10, the administrative manpower requirement would be 2.7 or 27 percent of the staff. For 20 employees, this guideline will gradually decrease. The following is a summary of administrative manpower requirements based on a staff in increments of 10.

No. of Staff	Director	Deputy Director	Supervisors	Clerical	Total No.	Per Cent of Staff
10	1		1	2/3	2 2/3	27
20	1	1	2	1 1/3	5 1/3	27
30	1	1	3	1 2/3	6 2/3	22
40	1	1	4	2	8	20
50	1	1	5	2 1/3	9 1/3	19
60	1	1	6	2 2/3	10 2/3	18

In Table 2.7A, an average figure of 25% has been used to estimate manpower requirements for program administration.

Based on information obtained from EPA fiscal budgets, personnel costs comprise the largest portion of administrative costs. Two types of personnel costs are involved—direct and indirect costs. The indirect personnel cost is that portion of costs charged to the water supply program for personnel in the centralized services, such as personnel, accounting, purchasing, etc. Direct personnel costs are the costs for supervisory personnel involved with the administration of water supply program activities. The costs in table 2.7B have been estimated as 40

percent of the surveillance and training activities. This figure is believed to be an average cost. The real cost may vary from 20 to 70 percent depending on the accounting methods used. For instance, if centralized services are not charged to the water supply program budget, personnel costs for supervisory personnel would comprise the bulk of administrative costs. Program costs for administration would then be on the low side of the 20 to 70 percent range. On the other hand, if centralized services are charged to the program's budget, the figure may reach the high side of this range. Development of costs for any particular program will require consideration of this situation.

2.7.0 *Summary of Costs for Community Water Supply Systems*

Costs for surveillance of community water supply systems have been developed in the preceding pages. An idea as to the magnitude of total program costs can be obtained if these individual costs are summarized on a cost per system basis. For this purpose, community water supply program costs have been summarized in Tables 2.7A and 2.7B for three average size systems.

TABLE 2.7A—*Estimated State Water Supply Program Manpower Needs for Community Water Supply Systems*

Program Activity	Man-Days/System/Year		
	35,000 or less	35,000–100,000	100,000 or larger
Surveillance			
Sanitary Surveys, Tech. Asst.	4.00	4.00	4.00
Chemical Surveillance	1.77	1.77	1.77
Bacteriological Surveillance	.66	1.32	3.30
Bacteriological Laboratory Certification[a]	[b]	1.17	1.83
Training	.76	.76	.76
Subtotal	7.19	9.02	11.66
Program Administration (25% of Surveillance & Training)	1.80	2.25	2.91
Total	8.99	11.27	14.57

[a] Manpower estimates for bacteriological certification of small laboratories are used for systems under 100,000 and the manpower requirements that have been developed for large or regional laboratories are used for systems over 100,000.

[b] Available information suggests that few of the smaller utilities maintain a bacteriological laboratory. Since an estimated 85–90 percent of all water supply systems serve a population under 10,000, the manpower estimate for certifying bacteriological laboratories in the 35,000 or less size group is omitted.

TABLE 2.7B—*Estimated State Water Supply Program Costs for Community Water Supply Systems*

Program Activity	System Size		
	35,000 or less	35,000–100,000	100,000 or larger
Surveillance			
Sanitary Surveys, Tech. Assist.	$360	$ 360	$ 360
Chemical Surveillance	161	161	161
Bacteriological Surveillance	120	240	600
Bacteriological Laboratory Certification[a]		100	159
Training	69	69	69
Subtotal	$710	$ 930	$1,349
Program Administration (40% of Surveillance & Training)	284	372	540
Total	$994	$1,302	$1,889

[a] Bacteriological certification costs for small laboratories are used for systems under 100,000 and the cost that has been developed for evaluating large or regional laboratories is used for systems over 100,000.

2.8.0 *Surveillance Costs for Other Public Water Supply Systems*

It is generally agreed that the States have a responsibility to provide some degree of surveillance over the public water supply systems that do not fall into the classification of community systems. In arriving at an average surveillance cost for these public water supplies, the following assumptions were made:

- One man day per system per year should be allocated for sanitary surveys and related technical assistance. This is based on the assumption that an annual inspection of these systems requires approximately one-fourth the time required for community water supply systems.
- One chemical analysis will be performed for each system every 3 years as a minimum (refer to Appendix B). An estimated 5% of the systems use surface water sources and 95% use ground water sources.

Calculation:

Man-days required for analysis of surface water source—5.50

Man-days required for analysis of ground water source—2.50

$$\begin{aligned} 5\% \times 5.50 &= .27/\text{source} \\ 95\% \times 2.50 &= 2.37/\text{source} \\ &\overline{\quad 2.64/\text{source}} \end{aligned}$$

$$\frac{2.64}{3} = .88 \text{ man days per system per year}$$

$$\frac{.88 \text{ man-days/system/year} \times \$20{,}000/\text{year}}{220 \frac{\text{man-days}}{\text{year}}} = \$80/\text{system/year}$$

- A minimum of 2 bacteriological samples will be performed monthly for each supply at a cost of $5 per sample. As shown in section 2.2.1, this will require approximately 0.66 man days per system annually.

Based on an EPA estimate of 200,000 systems in this category, the total program costs to the States are over $81 million; far in excess of the costs of the community water supply program. On the basis of cost, and in recognition of the practical problems of providing surveillance over such a large number of systems, some judgment must be exercised. Consideration must be given to the size of the public health risk, in terms of the population affected, and the benefit/cost relationship of providing surveillance. Clearly, the busy restaurant, with its own water supply, on an interstate highway is a greater potential public health problem than a system serving six rural homes or an isolated country store.

TABLE 2.8A—*Estimated State Water Supply Program Manpower Needs for Other Public Water Supply Systems*

Program Activity	Man-days Per System Per Year
Surveillance	
Sanitary Surveys, Tech. Asst.	1.00
Chemical Surveillance	.88
Bacteriological Surveillance	.66
Subtotal	2.54
Program Administration @ 25% of Surveillance	.63
Total	3.17

TABLE 2.8B—*Estimated State Water Supply Program Costs for Other Public Water Supply Systems*

Program Activity	Cost
Surveillance	
Sanitary Surveys, Tech. Asst.	$ 90
Chemical Surveillance	80
Bacteriological Surveillance	120
Subtotal	$290
Program Administration @ 40% of Surveillance	116
Total	$406

Section 3 CURRENT STATUS OF WATER SUPPLY SYSTEMS

The ultimate measure of the adequacy of a State water supply program is the quality and availability of water provided the public and the condition of the State's water supply systems. A review of a representative sample of the State's water supplies will provide valuable information concerning the State's program as well as developing a "base line" for future evaluation. Since the purpose of the survey is to provide a basis for the objective evaluation of the State's program, ideally such a review should be conducted by an independent group such as a Federal agency or private consultant.

The purpose of the sanitary survey is to determine the condition of the State's water supplies and the effectiveness of regulatory activities through:

- Inspections of the source of water, treatment plants, and distribution systems.
- Laboratory analysis of drinking water samples for bacteriological, chemical, physical, and radiological constituents.
- Examination of pertinent data recorded in State, county, or municipal files.

Public health protection of drinking water supplies should assure that each component of the production, storage, and distribution process functions with minimum risk of failure. Flawless treatment avails nothing if the distribution system permits entrance of contamination through faulty facilities such as unprotected storage or cross-connections. Similarly, excellent operation of conventional water treatment and distribution facilities will not protect public health if impurities which are not removable by treatment are present in the raw water source.

3.1.0 *Survey Methods*

On-site inspections of water supply facilities and operating procedures, and bacterial and chemical sampling at representative points in the water supply system is the preferred method of conducting a sanitary survey. This approach may, however, prove too costly in terms of available manpower and financial resources. Time of completion may also be a factor that will have to be reconciled. In instances where these factors may be prohibitive, it may be necessary to confine the sanitary survey to a "records audit." A survey of this type can often result in a measure of success, particularly in States where records are fairly complete and up-to-date.

The records audit can determine frequency of inspections, frequency of bacterial and chemical sampling, the history of bacterial and

chemical quality, the number of chemical constituents analyzed and operator qualifications. In addition, plant operation reports can indicate the level of plant operation and control.

The principal disadvantage, however, is that the records audit does not permit a fully objective assessment of the State surveillance activity. If the survey is undertaken on the stated premise that the ultimate measure of the adequacy of a State water supply program is the condition of the State's water supply systems, then this adequacy cannot be objectively determined by using past surveillance records. These have been obtained using methods, criteria, etc., the adequacy of which is the objective of the review. The "records audit" may indicate that engineering inspections have been made at a satisfactory level of frequency, but "engineering inspection" is a term whose meaning is subjected to a variety of interpretations. The records audit has to assume for the most part that the inspection was adequate in determining the sanitary condition of a water supply system.

On the other hand, on-site inspections will not obviate the need for a thorough review of existing records. A review of existing State records should be thought of as an essential preliminary step before the field study is undertaken. Ideally, the records audit and the field investigation should be considered a complementary procedure for an effective evaluation.

3.2.0 *Selection Criteria*

The State must be concerned with all public water supply systems and the evaluation should include all types even if administered by different organizational units. The regulation of small public water supplies may be restricted by statute, regulation, or by administrative policy. Surveillance authority is sometimes the responsibility of the county health agency. Small public supplies serve the public in a variety of private and commercial establishments, such as restaurants, motels, subdivisions, trailer courts, schools, parks, recreation areas, etc. They may influence the health of many people and should be included as a part of the evaluation of the State's water supply program.

- Community water supplies that reasonably represent water supply practice in the State should be selected for study. They should be selected to reflect:
  - — System size
  - — Types of sources and methods of treatment
  - — Geographical location within the State
  - — Political subdivision or water supply surveillance districts.
- Other public water supplies, due to their large numbers, can probably best be selected for study by counties or districts. The selection by counties is also convenient since a county health agency is often responsible for these supplies and any records are

maintained at the county offices. Criteria for selection should include the following:

— Counties should be selected in each geographical area of the State.
— Since the source for these supplies is generally ground water, the counties selected should reflect the different types of geographical formations in the State.
— Selection should be based on the methods and types of well construction since well construction may vary greatly within a State.

3.3.0 *Review of Water Supply Records*

Preparation for the on-site inspection of a water supply should include the compilation and review of all pertinent and available information on that water supply before the inspection is undertaken. Acquisition of data concerning water quality, physical facilities, operation, personnel, State and local laws, and rules and regulations relevant to the supply not only provides the basis for a more thorough and accurate inspection but often saves considerable time during the inspection.

3.3.1 *Community Water Supply System Data*

The files of the State water supply program agency will be the best, and more than likely the only, source of background information on community water supply systems in a State. These files should be examined for the following data:

- Inventory of each community water supply:
  — The name and address of the water utility
  — Population served; number of services, meters and customers
  — Ownership
  — Source(s) of supply
  — Treatment
  — Laboratory control
  — Plant capacities in terms of normal operation, distribution, storage and emergency production.
  — Average and maximum daily production.
- Water quality data—The past history of water quality both raw and finished should be determined by review of available records for:
  — Bacteriological quality
  — Physical quality
  — Chemical quality
  — Radiological quality.

(The data should be reviewed for both quality and frequency of sampling.)

- Sanitary Survey Inspections—State files should include all sanitary survey inspections conducted by the State water supply agency. Engineering inspection reports are one source of comprehensive

information that can be obtained on a public water supply system which should be reviewed with care prior to a field inspection.

- Water Supply System Personnel—The management, size of staff, their qualifications, training, experience, and capabilities should be reviewed. Review of operator qualifications should be determined in light of existing State operator classifications for the type and size of plants and any existing voluntary or mandatory certification programs existing in the State. This information will generally be available in the engineering inspection reports. However, some States, particularly those with certification programs, will have separate files on public water supply system operators.

3.3.2 *Other Public Water Supply System Data*

The first requirement will be to determine the regulatory authority responsible for the data on these water supplies. Often this is the county or local health department. The State health department may maintain some files. As in the case of community water supplies, as much data as possible should be obtained on water quality, physical features, and operation. Where the county or local health departments are responsible for surveillance, their files should be examined for surveillance reports, water quality tests, and complaints. A thorough files search for data on small public water supplies is perhaps more critical than that for community supplies. Historical and operations data that may be readily available at larger community supplies are often more difficult to obtain during the field inspection visit to a small supply. The following are examples of some of the data that should be obtained:

- Name of supply and/or ownership and address
- Population served—permanent and transient
- Characteristics of service area, i.e., recreational area, mobile home park, school, etc.
- Capacity of supply and average and maximum daily production
- All water quality data available
- Frequency of sampling for each class of constituents
- Any available operational reports
- Number and frequency of inspections
- Source of supply—spring, well, cistern or surface supply
- Type of groundwater formation
- Contractor or person who constructed supply
- Was contractor licensed?
- Age of constructed supply
- Wells
  - — Type of well
  - — Method of construction
  - — Protection provided—seals and covers
  - — Casing, screens, pitless adaptors, etc.

- Springs—type of construction and protection provided
- Cisterns—catchment area, construction, protection and provision for cleaning
- Pumps provided
- Treatment provided
- Storage
- Extent of distribution system, if any.

A search of the files should determine if a well log is available. The type and quantity information provided by a well log will vary considerably and they often contain very little information concerning the sanitary features of well construction such as sanitary seals, covers, etc. However, some well logs are comprehensive and are a valuable source of information for use in conducting a sanitary survey. Well logs, county, local and State files should be searched for the informational items listed above preliminary to a survey of public water supplies.

3.4.0 *Evaluation Criteria*

The effectiveness of a State water supply program can be determined to a large degree on the basis of:

- water supply system water quality
- surveillance of water supply systems
- adequacy and condition of water system facilities.

Over the past ten years, the Federal Water Supply Program has conducted field surveys and evaluations of a large number of public water supply systems. While these evaluations were done as a part of several different projects and activities, they all have had one point in common: that is, the water supply systems were evaluated against the *Drinking Water Standards*. In addition to providing constituent limits for bacteriological, chemical, physical, and radiological contaminants, the Standards require that the physical facilities, the operation, and the surveillance provided by the appropriate regulatory agency must be taken into consideration.

In order to provide additional criteria in evaluating a supply, EPA's "*Manual for Evaluating Public Water Supplies*" was developed. A more recent document entitled, "*A Guide to the Interstate Carrier Water Supply Certification Program*," [11] has been issued to promote a more uniform application of the *Drinking Water Standards*. Nevertheless, a considerable amount of judgment is required on the part of the evaluator in interpreting the relative effect of the facilities, their operation, and the surveillance on the dependability of the overall water system.

3.4.1 *Water Quality*

- Bacteriological quality of public water systems should be evaluated by comparing the previous 12 months bacteriological quality record against the *Drinking Water Standards*. Any system failing to meet

the bacteriological quality limits one or more of the past 12 months preceding the survey should be considered as having failed the bacteriological standard.

- Chemical quality of public water supplies should be evaluated on the basis of water samples collected from the distribution system. This is necessary since water may become contaminated while in the system by backflow of contaminated water through cross-connections and by the dissolution of substances from the materials in pipes, tanks, pumps, valves, meters, etc. The results of all chemical samples collected should be judged on the basis of the "mandatory" and "recommended" constituent limits of the *Drinking Water Standards*.

3.4.2 *Surveillance*

Water supply surveillance should be judged on the basis of the *Drinking Water Standards* and the *Manual for Evaluating Public Drinking Water Supplies*.

3.4.2.1 *Community Water Supply Systems*

- Bacteriological surveillance is considered satisfactory if the number of bacteriological samples examined per month during the preceding 12-month period meets the minimum number specified by the *Drinking Water Standards*.
- Chemical surveillance is considered satisfactory if chemical constituents (as distinguished from normal in-plant operational checks) were determined according to the following schedule and there was no record of significant problems:
  - — Surface water source—at least once per year
  - — Ground water source—at least once every three years
- Engineering surveillance is considered satisfactory if an inspection by the State regulatory agency has been made at any time during the 12-month period preceding the survey. More frequent inspection, however, is considered necessary for optimum surveillance.

3.4.2.2 *Other Public Water Supplies*

It would be desirable for the State program to provide direct surveillance for small public water supplies. As a practical matter, however, this may be impossible in some States due to limited monetary and personnel resources and the surveillance of these supplies are often the responsibility of the local and county health departments. Thus it becomes the responsibility of the State to assure adequate regulation of small public supplies by the establishment of rules and regulations and close liaison with local and county health departments to insure proper reporting and maintenance of data. Technical assistance and laboratory resources should also be readily available on request. These services are particularly important since, in general, routine surveillance of small

public water supplies is provided by sanitarians who are not fully trained in the engineering disciplines relating to water supply facilities.

Bacteriological, chemical, and engineering surveillance requirements are similar to those listed for community water supplies. The *Drinking Water Standards* provides for submission of at least two bacteriological samples monthly for all supplies serving the public regardless of the size of the population served.

3.4.3 *Water Supply Facilities*

In evaluating the health risk of a water supply system, a detailed and comprehensive sanitary survey of water system facilities should be conducted on those water supply systems selected for study.

The following features of a public water supply system should be evaluated:

- Source
  - — Quality
  - — Quantity
  - — Protection
- Treatment
  - — Facilities
  - — Operation
- Distribution
  - — Storage
  - — Pressure
  - — Chlorine Residual
- Quality Control
  - — Records and tests
  - — Cross-connection control.

These features should be evaluated on the basis of the *Manual for Evaluating Public Drinking Water Supplies* and the *Drinking Water Standards*. The *Manual for Evaluating Public Drinking Water Supplies* recommends procedures for surveying and evaluating a water supply and describes the elements of water treatment generally necessary to insure the production of water that continuously meets the requirements of the *Drinking Water Standards*. It is intended to serve as a guide to those whose task it is to evaluate public water supply systems and deals primarily with health hazards attendant on the production of a potable drinking water.

In the final analysis, however, the professional judgment of the individual conducting the survey is all important. His competence determines the reliability of the data collected. Thus only qualified persons should conduct the sanitary surveys. The person conducting a survey should have a technical education in basic sanitary sciences and engineering experience with the sanitary features of potable water supplies. Such qualifications will lend credence to the subjective

judgments he is often required to make in determining the health risk of a system.

3.5.0 *Data Collection*

Evaluation data forms will be needed for the on-site inspection. Most State water supply program agencies have developed survey forms that are used to gather pertinent data on an engineering inspection. These forms should be completed to the greatest extent possible with the data obtained from the files before the visit is made.

In some instances, State survey reports include a method of rating a water supply system—generally on a numerical basis. Regardless of whether or not such a rating system is used, the important consideration and the basic survey objective is to collect sufficient information to determine conclusively the capability of a water supply to continuously provide water that meets the *Drinking Water Standards*. The sanitary features of a public water system believed to be of primary importance have been discussed here in general terms. The deficiencies found during the survey should be listed in the survey report. Although ratings and risk factors are often assigned to these systems on a numerical basis, they can often be misleading, particularly if the more important sanitary features of a system are not weighted according to the health risk they pose. In all evaluations, it must be remembered that there are three parts of the *Drinking Water Standards* that must be met: the bacteriological limits, the chemical and physical limits, and most important, those portions relating to "source and protection." This latter portion refers to operation, facilities, quality control, and reliability of the system.

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APPENDIX A
INDIVIDUAL WATER SUPPLIES

General

Fifty million people in this country either obtain water from individual water supplies or have no readily available source and have to haul their water. The subject of individual water supplies was not covered in the main body of the manual since the regulation of an individual's water supply is not considered to be a proper role of State government in its reasonable exercise of power to protect the public health. It is recognized, however, that each citizen of the State has a right to expect that government will provide certain safeguards in matters relating to his health. Yet studies conducted by EPA [12] indicate that very little has been done by regulatory agencies to investigate and insure the safety of these water supplies. These studies confirm earlier studies conducted by a number of States that point to serious deficiencies in systems serving individual families.

It is suggested that the principal contribution of State government can be the development and coordination of a plan for sharing responsibilities between State, county, or district, and local health agencies. Although direct State involvement should generally be limited to providing technical assistance to improve these supplies through local agencies, the single most effective means available is through the effective regulation and enforcement of a well construction program. In developing a plan of assistance for the improvement and protection of individual water supplies certain areas of assistance are suggested.

State Assistance

- Establish an active surveillance plan coordinating efforts at the State and local levels.
- Establish requirements for well construction:
  - — Examination and licensing of well drillers
  - — Issuance of permits for construction
  - — Adoption of a well construction and pump installation code.
- Investigate well construction violations and issue compliance orders.
- Provide technical assistance to local agencies on request.
- Provide laboratory support to local agencies when water quality analysis requires sophisticated equipment and techniques local agencies are unable to provide.
- Establish an educational program to inform the public of dangers that may exist in individual water systems.

Local Assistance

- A program to provide a sanitary inspection and complete bacteriological and chemical analysis of each new individual water supply before it is placed in use. The physical facilities and water quality should meet the criteria adopted in the State regulations. Control of well supplies can be achieved by effective well drilling regulations and codes established by the State. The well inspection program should also provide for pre-construction site visits to determine environmental conditions that would threaten the sanitary safety of a constructed well such as the nature, distance and direction of pollution sources, slope of ground surface, soil conditions, extent of drainage area, etc.

- Technical assistance to individual water supply owners on request including bacteriological and chemical analysis of the owner's water supply. The locality may wish to provide this service on a fee basis.
- Reporting of violations of State codes and well drilling regulations to the State water supply program agency and conducting spot checks to determine compliance. The local agency should assume responsibility for field visits and supervision during well construction.
- Reporting of all individual water supply health hazards and suspected waterborne disease incidents to the State program agency as well as the individual home owner. (Appropriate assistance should be provided by the locality to assist the individual owner in correcting and eliminating the health hazards.)
- Maintenance of an inventory of individual water supplies including well logs, sampling data, records of inspections, violations, etc.

Well Construction Control

An effective well driller licensing program and good construction codes fairly and effectively enforced, produce many tangible benefits. They:

- Permit health department personnel to make sound judgements on the quality of well construction and the safety of water sources.
- Increase the safety, reliability and useful life of water systems.
- Provide the consumer with a safer source of water.
- Reduce the consumer's water costs significantly by increasing the useful life of the installation and by reducing the need for costly repairs and servicing.

Effective ground water resources management requires the removal of archaic and obsolete laws from the law books and their replacement with statutes whose terminology, phraseology, and definitions are based on modern technological understanding of ground water occurrence and movement. There has been a "Model Water Well Construction and Pump Installation Law" recommended for adoption by the States since July 1964.[13] Its development was promoted by the "Committee for Private Water Resource Protection," which, in turn, was sponsored by, among others, the National Water Well Association and the Water Systems Council. It was endorsed by the U.S. Public Health Service, the Conference of State Sanitary Engineers, and the American Public Health Association. Furthermore, its content represents the consensus of more than 100 drillers, pump installers, and suppliers across the country.

Qualified segments of the industry can offer valuable assistance in the preparation of well construction codes suitable to the geology of the regions concerned and the equipment and methods used. However, persons trained in engineering and public health are rarely encountered among drilling contractors, and these vital areas of concern should remain the responsibility of qualified State or local government personnel. For this reason, it is important that the State program agency administer a coordinated assistance program with local regulatory agencies. The assistance program will be more effective if local personnel handle routine administration of the program, including inspections, sample collection, and record-keeping.

The State should support these activities by providing special services beyond local capabilities such as laboratory and technical support. In addition, the State program agency should investigate construction violations reported by local agencies and issue compliance orders to correct deficiencies and eliminate health risks.

Sanitary Inspection of Individual Water Supply Facilities

Many of the items discussed in section 3 concerning small public water supply systems may be applied to individual water supplies, particularly those on well construction. Individual water supplies that may be encountered in a sanitary survey can be classified as:

- Ground water
  - — Wells

  - — Springs
- Cisterns
  - — Rainwater catchments
  - — Hauled water storage tanks
- Surface water.

It is generally accepted by health agency personnel and water supply engineers that the problems in individual water supplies are primarily traceable to geology and construction deficiencies. The sanitary survey must investigate and evaluate these and other factors in order to assess the adequacy and safety of individual water supplies. There are three publications that will be valuable to the officer conducting the review:

- *PHS Drinking Water Standards*
- *Manual of Individual Water Supply Systems*
- *Manual for Evaluating Public Drinking Water Supplies.*

The survey officer should be thoroughly familiar with the content of these three publications before a survey is undertaken.

There are seven conditions[12] which offer an important warning of existing or potential danger in individual water supplies. Any one or a combination of these can mean polluted water and disease. The more that prevail in a given case, the greater is the danger. The danger signals are:

- Persistent illness—especially recurring intestinal disorders.
- An open well, open spring, or cistern supply.
- Muddy or turbid water following rain storms.
- Dug or hand-constructed well with jointed masonry casing.
- Well or spring located in pit or depression subject to flooding.
- Area of sink-hole, cavernous or fractured rock geology.
- Crowded residential area or industrial development without community sewage facilities.

APPENDIX B
CHEMICAL MONITORING

The chemical monitoring criteria recommended in this Manual are based on the 1962 Public Health Service Drinking Water Standards and EPA, Water Supply Division guidance. The 1962 PHS Drinking Water Standards are currently under revision. A change in the recommended frequency of chemical sampling is one item under consideration. This proposed change, summarized in the following paragraphs, is based on a concept of routinely monitoring for only those constituents in the standards where the potential for failing a limit is the greatest. This Manual will be revised to reflect this and other changes as soon as the new Drinking Water Standards and Guidelines are published.

Routine Monitoring

A routine monitoring program would be established for "selected" constituents where the potential for failing a limit is the greatest. A "selected" analysis would include all constituents which, in an initial record, or subsequent sampling analysis, were present at levels in excess of 50% of the limit, plus any other determination of potential "problem" contaminants as determined by the utility and the State regulatory agency. Where constituent levels equal or exceed the limits of the DWS, the frequency of sampling must be at least monthly. In any case, a selective analysis would be required at least annually for surface supplies and triennially for ground water supplies. A more complete analysis would be required whenever there is reason to believe there may be a significant change in water quality. After this analysis, an appropriate adjustment to the routine sampling schedule would be made.

Initial Record

To establish an initial record of water quality, a complete analysis of all chemical and physical constituents for which a limit is established would be required for all systems. This requirement would be considered fulfilled if a reliable analysis has been performed for each constituent in the past and there is no reason to suspect that a significant change in water quality has occurred. The State regulatory agency may waive the requirement for specific ground water sources, that an initial record for pesticides and/or organics-carbon adsorbable be established, if there is evidence to indicate that they will not be found at significant levels. A single complete analysis combined with a review of watershed and aquifer characteristics, possible avenues of contamination, potential pollution sources, and available environmental monitoring data will provide an acceptable initial record to establish a routine analytical program.

In summary, periodic analysis of "selected" parameters, coupled with information gained through other means such as periodic sanitary surveys, environmental monitoring, etc., will be a cost effective way to determine compliance with the physical and chemical constituents of the DWS. The proposed alternative monitoring requirement should result in a substantial reduction of cost over those recommended in this Manual.

APPENDIX C

WORK SHEET FOR ESTIMATING STATE PUBLIC WATER SUPPLY PROGRAM COSTS

STATE _____
PREPARED BY: _____
DATE: _____

I. DATA ON NUMBER OF WATER SUPPLY SYSTEMS

A. Community (Provides water to ten or more premises not owned or controlled by the supplier or to forty or more resident individuals)

Number surface water supplies* _____

Number groundwater supplies _____

B. Other Public Systems (all other systems which provide water for public consumption, exclusive of individual water supply systems)

Number surface water supplies* _____

Number groundwater supplies _____

* If the number of surface systems vs. groundwater systems are not known, assume 20 percent are surface supplies and 80 percent are groundwater supplies.

II. STATE COMMUNITY WATER SUPPLY PROGRAM COSTS

A. Surveillance

1. Sanitary surveys and related technical assistance

(a) _____ man-days required per supply for plan review, meetings, surveys, report writing, informal on-the-job training, etc.

(b) _____ man-days equals 1 man year

(c) Personnel costs:

_____ Salary

_____ Fringe Benefits

_____ Travel

_____ Office Supplies

_____ Office Space

_____ Secretarial Services

_____ Other

_____ Total

(d) Number of systems that one man year of surveillance efforts can provide:

Item (b) dividend by item (a) = _____

(e) Cost per system $\frac{\text{Item (c)}}{\text{Item (d)}}$ = _____

2. Chemical Surveillance

	Surface Water Sources		Groundwater Sources	
Analysis	Frequency of Analysis	Man-Days Per Annum	Frequency of Analysis	Man-Days Per Annum
Wet Chemistry	_____	_____	_____	_____
Trace Metals	_____	_____	_____	_____
Pesticides	_____	_____	_____	_____
CCE	_____	_____	_____	_____
Radiochemical	_____	_____	_____	_____
(a) Total		_____		_____

(b) Average Total Personnel Costs per man-day _____

(c) Cost/System = (a) × (b) _____ _____

(d) Cost/Surface system × % surface systems _____

Cost/groundwater system × % groundwater systems _____

Total cost/system _____

3. Bacteriological Surveillance

(a) Labor estimate per sample (man-days) _____

(b) Average personnel cost/year _____

(c) Labor costs per sample $\frac{\text{(b)}}{\text{M.D./year} \div \text{(a)}}$ _____

(d) Postage, sampling bottles, mailing costs and labels/sample _____

(e) Total cost per sample = c + d _____

(f) Average number sample/system/year _____

(g) Cost/system/year = (e) × (f) _____

(h) Labor/system/year = (a) × (f) _____

4. Laboratory Certification

(a) Estimated number of man-days per laboratory survey (include survey preparation, travel time, site visit, report preparation) _____

(b) Average annual estimated personnel costs for laboratory certification (include salary, fringe benefits, travel, office supplies, office space and secretarial support) _____

(c) Cost per laboratory survey _____

$$\frac{\text{(a)} \times \text{(b)}}{\text{number man-days per man-year}}$$

(d) Annual cost per laboratory certification _____

(c) × Frequency of Certification

(e) Annual manpower requirement per laboratory certification _____

(a) × Frequency of Certification

(f) Number of laboratories to be certified

State-Regional, district, etc. _____

Local or County Health Department _____

Water Utility _____

Commercial _____

Other _____

Total _____

(g) Annual cost per system _____

$$\frac{\text{(d)} \times \text{(f)}}{\text{number of community systems}}$$

(h) Manpower (man-days) requirement per system _____

$$\frac{\text{(e)} \times \text{(f)}}{\text{number of community systems}}$$

B. **Training**

1. State Staff:

(a) Number of days training that each professional should receive annually _____

(b) Cost/day excluding salary _____

(c) Cost/system/year

(a) × (b) divided by II.A.1.(d) = _____

2. Operators:

(a) Number of days of *State-sponsored* training that each principle operator should receive annually _____

(b) Cost *to State* for providing the training per trainee day _____

(c) Cost/system/year = (a) × (b) _____

3. Total Cost: 1.(c) + 2.(c) _____

4. Manpower for training

(a) Number of man-days per system per year _____

$$\frac{\text{Cost/system/year (B.3)} \times \text{Number of Man-days in a Year}}{\text{Personnel costs per year (II.A.1.(c))}}$$

C. **Management and Overhead**

1. Estimated percent of surveillance and training costs for program administration _____

   (a) Cost per system per year _____

2. Estimated percent of surveillance and training manpower requirement for program administration _____

   (a) Number of man-days per system per year _____

SUMMARY
STATE WATER SUPPLY PROGRAM COSTS AND MANPOWER REQUIREMENTS
COMMUNITY WATER SUPPLY SYSTEMS

	Man-days Per System Per Year	Dollars Per System Per Year
Surveillance:		
Sanitary Surveys	_____(II.A.1.(a))	_____(II.A.1.(e))
Chemical Surveillance	_____(II.A.2.(a))	_____(II.A.2.(d))
Bacteriological Surv.	_____(II.A.3.(h))	_____(II.A.3.(g))
Laboratory Certification	_____(II.A.4.(h))	_____(II.A.4.(g))
Training:	_____(II.B.4.(a))	_____(II.B.3)
SUBTOTAL:	_____	_____
Program Administration	_____(@___%) (II.C.2.(a))	_____(@___%) (II.C.1(a))
TOTALS PER SYSTEM	_____	_____

Cost of State Community Water Supply Program is: _____

Number systems × cost/system

Manpower requirements of State Community Water Supply Program is: _____

$$\frac{\text{Number systems} \times \text{man-days/system/year}}{\text{number man-days/year}}$$

STATE WATER SUPPLY PROGRAM COSTS AND MANPOWER REQUIREMENTS FOR OTHER PUBLIC WATER SUPPLY SYSTEMS

The basic unit costs for community water supply systems should be used to calculate the program costs for the smaller public water supply systems.

	Man-days Per System Per Year	Dollars Per System Per Year
Surveillance:		
Sanitary Surveys	_____	_____
Chemical Surveillance (give basis for cost)	_____	_____
Bacteriological Surveillance (give basis for cost)	_____	_____
Other (specify)	_____	_____
SUBTOTAL:	_____	_____
Program Administration @ ___%	_____ @ ___%	_____ @ ___%
TOTALS PER SYSTEM	_____	_____

Cost of State Program for Other Public Water Supplies is: _____

Estimated number of systems × cost/system

Manpower requirements for Other Public Water Supplies: _____

$$\frac{\text{Estimated number of systems} \times \text{man-days/system/year}}{\text{number man-days/year}}$$

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